INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(54) Title: SINGLE-AXLE BOGIE FOR TRACKBOUND VEHICLE

(57) Abstract

The invention relates to a self-steering single-axle bogie for trackbound vehicles comprising one single wheel set (8) and wherein each wheel (8a, 8b) is rigidly connected to an intermediate wheel axle (14), wherein the wheel set (8) is attached rigidly or by means of springs (10) to a bogie frame (2), which is rotatably arranged around a vertical axis. Further, the bogie is joined to the car body (4) of the vehicle via at least one toggle link (16) extending in the longitudinal direction of the vehicle and preventing the bogie from tilting, or nodding, in the vertical longitudinal plane through the vehicle. The wheels (8a, 8b) exhibit conical or saddle-shaped treads (18), with an elevated conicity at least in the tread (18) nearest the wheel flange, the wheel set (8) being guided into approximate radial alignment in the track through the combined effect of the conicity of the wheels (8a, 8b) in the tread (18) and the frictional forces which act between wheels (8a, 8b) and rails (20a, 20b).

Single-axle bogie for trackbound vehicle

TECHNICAL FIELD

5   The present invention relates to a single-axle bogie for a
     trackbound vehicle, wherein a wheel set rigidly inter-
     connected by means of an intermediate axle is mounted in a
     bogie frame, which is rotatable around the vertical axis of
     the frame and wherein the whole bogie is self-steering when
10   negotiating a curve.

BACKGROUND ART

     The current technique of providing long, trackbound vehicles
15   with wheel arrangements is generally based on utilizing
     bogies, that is, rotatable, load-carrying frame structures
     which comprise two or more wheel sets, wheel axles and wheel
     suspension and wherein at least two bogies support a car
     body, the concept car body in this context being defined as
20   the device which is intended to contain and/or constitute
     the base for the useful load (or payload). A variety of
     solutions for steering such bogies through track curves, and
     devices for minimizing oscillating movements during running,
     have been described over the years and at present constitute
25   examples of well-tried technique. Of necessity, however,
     this type of bogies becomes heavy.

     The reason for using bogies is also explained by the fact
     that the frame in the bogie permits two suspension levels
30   between track and car body as well as improved possibilities
     of suspension of brake and drive equipment.

     There is a desire to make the vehicles simpler and lighter,
     both in view of purchase and maintenance costs and in view
35   of energy consumption when starting and stopping the
     vehicles. This also gives rise to a desire to reduce the
     weight of the bogies. One way of achieving bogies with lower
     weight is to start to use single-axle bogies. The wheel axle

in a single-axle frame must be given the possibility of
steering through track curves, while at the same time it is
desired to counteract tendencies to oscillation and winding
of the bogie when driving at higher speeds.

5

In track curves the wheel axles in a trackbound vehicle
should be aligned radially or almost radially to the track
curve to make it possible to negotiate curves without fric-
tion arising and without significant wear of wheels and

10   rails. Steering a wheel axle through a track curve means
that the wheel axle is aligned radially to the track curve,
but may just as well be expressed in such a way that the
wheels are aligned and roll in the direction of tangent of
the rails, or almost along with the direction of tangent of

15   the rails.

Within railway engineering, there has long been a desire to
find a practicable model of a single-axle bogie. It is known
to try to equip trackbound vehicles with single-axle bogies

20   with a wheel set, where the wheel set is journalled in a
bogie frame and this bogie frame is rotatable around the
vertical axis. In German patent specification DE 37 18 254,
C2, referred to here as D1, a proposal for such a single-
axle bogie is described. This specification describes a two-

25   wheel bogie, the wheels of which are journalled in a bogie
frame which is attached to the car body of the vehicle for
taking up tractive efforts and braking forces. Further, the
direction of rolling of the wheels is determined by a
guiding device. In addition, via resilient elements the

30   wheels are movable vertically and in lateral direction in
relation to the car body and tangentially align able in
relation to the direction of track. To make possible radial
guiding of the bogie through a track curve, the bogie is
adapted to be rotatable around the vertical axis. A guiding

35   device which consists of, for example, guide rods extending
from an adjacent bogie of the train transmits steering
forces to the bogie wheels such that the wheels are aligned
tangentially to the track direction in a track curve. In

addition, the bogie frame is connected to the car body
through at least one link arm which extends in the longitu-
dinal direction of the vehicle and which allows the rotation
of the bogie frame around the vertical axis, but which at

5   the same time prevents the bogie from tilting over around
the transverse axle of the bogie during braking and
acceleration.

The tread of a railway wheel is usually slightly conically

10   shaped. The wheel has a certain conicity. According to a
well-known pattern, this means that a wheel set or a bogie
rotatable around the vertical axis displays a tendency to
describe a sinusoidal motion when travelling on straight
track. This property contributes to reduce the critical

15   speed when driving a trackbound vehicle. The guiding device
according to patent specification D1, mentioned above, also
has the task of counteracting the oscillating and winding
tendencies of the single-axle bogie when travelling on
straight track.

20

A considerable disadvantage of the solution that the
introduction of a single-axle bogie described in patent
specification D1 entails is the need of the long guide rods
which transmit the steering forces to the bogie. These guide

25   rods are clumsy and unwieldy, especially when extending from
the front to the rear bogie in the same vehicle, where the
guide rods may have a length of over 10 m. In addition,
under certain conditions, incorrect steering forces are
transmitted via these guide rods, for example when a vehicle

30   enters and exits a track curve and when passing through
points with two adjacent and consecutive curves in different
directions, where the radial alignment of a wheel axle to
the track direction is to be different from that which the
guide rods of the guiding device tend to align. This may

35   cause extra wear on wheels and rails and in critical situa-
tions an increased risk of derailment. In addition, the
guide rods described can cause maintenance problems, such as
the need for accurate alignment and problems with wear and

play in the joints of the guide rods. Furthermore, the long guide rods may cause oscillations and vibrations in the vehicle.

5   From US patent specification 4 067 261 it is known to design a bogie with self-steering, that is, that the wheels in the bogie are aligned tangentially to the rails in a track curve, by the treads of the wheels having elevated conicity and hence strive to align the bogie in the track direction.

10   However, the device according to the specification only relates to two- or multi-axle bogies or single wheel axles attached directly to a car body. This specification does not describe any solution regarding self-steering single-axle bogies or demonstrates any necessary auxiliary devices for

15   achieving a well-functioning self-steering single-axle bogie.

The conicity of the tread of a railway wheel is a measure of the degree of increasing wheel radius measured in a radial

20   section across the tread of the wheel in a direction towards the wheel flange. Usually, the concept effective conicity is used, since the wear on the tread of a wheel changes the original purely conical shape of the tread of the wheel, whereby the tread may assume a saddle shape. By effective

25   conicity is then meant the ratio of the change of the radius of rolling of the wheel to the lateral movement of the wheel across the rail.

SUMMARY OF THE INVENTION

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The invention relates to a self-steering single-axle bogie for trackbound vehicles which comprises one single wheel set and wherein each wheel is rigidly connected to an interme- diate wheel axle, the wheel set being attached rigidly or by

35   means of springs to a bogie frame which is rotatably arranged around a vertical axis. Further, the bogie is joined to the car body of the vehicle via at least one toggle link which extends in the longitudinal direction of

the vehicle and which prevents the bogie from tilting, or
nodding, in the vertical longitudinal plane through the
vehicle. The wheels exhibit conical or saddle-shaped treads,
with an elevated conicity at least in the tread nearest the
5   wheel flange, the wheel set being guided to an approximately
radial direction in the track through the combined effect of
the conicity of the wheels in the tread and the frictional
forces which act between the wheels and the rail.

10 The bogie frame is attached, for example by means of
springs, to the car body in the vehicle such that the bogie
is allowed a certain movement also around the longitudinal
axis of the vehicle as well as vertically and laterally in
relation to the car body.
15

The attachment of the bogie frame to the car body is perfor-
med with such a rigidity that the forces on the wheels,
which are generated by the self-steering ability, are at
least as great as the yaw resistance (resistance to rotation
20 in the horizontal plane) which is caused by the attachment
means, for example by the resilience which occurs between
the bogie and the car body. In this way, the bogie wheels
are aligned in the tangential direction of the track curve
when negotiating curves.
25

To avoid the above-mentioned problem occurring in bogies
with a self-steering ability, of describing a periodic
oscillating movement in the direction of travel at higher
speeds on straight track, the bogie may be equipped with
30 dampers, preferably arranged in the longitudinal direction
of the vehicle, between the sides of the bogie frame and the
car body. These dampers are designed with a speed-dependent
characteristic, whereby the damper exhibits a high damping
in relation to the high-frequency winding motions with a
35 relatively low amplitude (1 - 2 mrad) of the bogie which may
occur at a high speed and a lower resistance to the relati-
vely low-frequency rotary motions which are caused by the

vehicle, with the bogie used for the purpose, being about to enter or exit a curve.

The winding motions can be reduced further by introducing a

5   rigidity to yawing between the car body and the bogie frame.

The toggle links which prevent the bogie from tilting in the longitudinal direction of the vehicle permit the rotations of the bogie when the bogie rotates in the horizontal plane,

10   since the toggle links are articulately joined to the car body.

The object of the invention according to the description is to arrive at a very light bogie also for relatively fast

15   trackbound vehicles. Furthermore, the intention is to achieve a bogie with simple technique and with properties which contribute to low wear of wheels and rails.

BRIEF DESCRIPTION OF THE DRAWINGS

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Figure 1 schematically shows a side view of a single-axle bogie according to the invention.

Figure 1b shows a modified embodiment of a toggle link for

25   the bogie.

Figure 2 schematically represents the same bogie in a view from above, the car body above the bogie being represented by its contours.

30

Figure 3 illustrates different tread profiles with elevated conicity.

Figure 4a shows by means of a diagram a speed-dependent

35   characteristic for a damping means with which the bogie is provided.

Figure 4b shows a stiffness characteristic for the resilient
attachment - associated with the bogie - to the car body of
the vehicle.

5   DESCRIPTION OF THE PREFERRED EMBODIMENTS

A number of embodiments of the invention will be described
with reference to the accompanying figures.

10   The figures illustrate a bogie frame 2 in a single-axle
bogie which is attached to a car body 4. The attachment can
be achieved by means of springs, secondary springs 6, but
also other flexible connections can be utilized. The wheels
8a, 8b are rigidly interconnected via an intermediate wheel
15   axle 14 and thus form a wheel set 8. The wheel set 8 is
attached rigidly or by means of primary springs 10 to the
bogie frame 2. The bogie frame 2 is rotatable about its
vertical axis through its flexible attachment to the car
body 4.
20
To prevent the bogie from tilting over in the vertical
longitudinal plane of the vehicle, the bogie frame 2 is
connected to the car body 4 of the vehicle via at least one
toggle link 16 which in the normal case, when travelling on
25   straight track, extends in the longitudinal direction of the
vehicle. The toggle link 16 is articulately arranged at its
connection to both the car body 4 and the bogie frame 2 in
order for the toggle link 16 to permit the bogie frame 2 to
rotate in the horizontal plane. Preferably, two parallel
30   toggle links 16 are arranged in the same vertical plane, one
of them suitably located higher than and the other lower
than the bogie frame 2. Figure 1b shows an alternative, in
which toggle joint 16 is designed with one link arm only.

35   To bring about the described self-steering, the treads 18 of
the wheels 8a, 8b are made with elevated conicity. The self-
steering is achieved in the single-axle bogie even at an
effective conicity which is greater than 0.05, but prefe-

rably the effective conicity is ≥ 0.2. This elevated coni-
city is exhibited by wheels with treads 18 which may have a
purely conical shape 18a or be saddle-shaped 18b, in which
case the conicity increases nearer the wheel flange.

5

When an outer wheel 8a of the bogie travels into a track
curve 20, the rail 20a and the wheel 8a contact each other
in an orbital path on the tread 18 of the wheel 8a nearer
the wheel flange than normally. A larger circumference is
10   imparted to the orbital path of the wheel 8a because of the
elevated conicity of the tread 18 of the wheel. In a corre-
sponding way, a smaller orbital path than normal is imparted
to the inner wheel 8b. This causes the wheel axle 14 and
hence the bogie to become aligned approximately radially to
15   the track. The steering effect is determined by the diffe-
rence in the radius of orbital path between the outer wheel
8a and the inner wheel 8b. The steering caused by the wheels
8a, 8b, which aligns the bogie in the radial direction of
the track curve 20, is illustrated in Figure 2.

20

To avoid the risk of winding movements when travelling
on straight track, especially at high speeds, dampers 22 are
arranged between the sides of the bogie frame 2 and the car
body 4. These dampers 22 are suitably horizontally mounted,
25   or mounted in some other way, with an effect such that the
rotary motions of the bogie, which are of relatively high
frequency, in the horizontal plane are damped. By motions of
a high frequency are meant in this connection preferably
rotary motions with a frequency exceeding about 2 Hz. In
30   addition, the dampers 22 are provided with a damping
characteristic which causes the bogie to perform, without
any major resistance, the relatively large (> 5 mrad) but
low-frequency rotary motions which are typical when entering
or exiting curves. Figure 4a shows a characteristic of the
35   damper function according to the guidelines described. The
damper force F_D on the bogie transmitted by the dampers 22
is shown in the figure as a function of the speed V_D of the
damper (in the case of damping movements). The curve indi-

cates the main operating range of the damper in case of
small amplitudes by A_{small} and the main operating range in
case of large but low-frequency rotary motions (e.g. when
the bogie enters a curve) by A_{big}. The damping is here
5   defined as the quotient between damping force and the speed
of the damper.

The flexible attachment of the bogie to the car body 4,
arranged, for example, by means of secondary springs 6, is
10   given a certain rigidity in relation to the rotation of the
bogie in the horizontal plane. This rigidity also contri-
butes to counteract the tendency to winding motions. Still
the rigidity is such that the forces, emanating from the
rigidity of the attachment device, which tend to counteract
15   a rotation of the bogie in the horizontal plane are not
greater than the steering forces which in a track curve 20,
because of the effective conicity of the treads 18 of the
wheels 8a, 8b, force the bogie to rotate in the horizontal
plane. The forces or moments of forces arising from the
20   attachment and acting against the steering action must not
be greater than the steering forces from the wheel set 8 in
all track curves, down to a smallest radius which normally
occurs in railway operation (c. 200 m).

25   For a vehicle with a car body and two bogies rotatable
therebelow, the angle of rotation (v) in the horizontal
plane, between each bogie and the car body, is approximately
equal to $v = A/R$, where A is half the distance in the
longitudinal direction between the centres of rotation of
30   the two bogies and R is the radius of the track curve.

The steering forces, F_x, on a bogie, caused by the conicity
of the wheels, can amount to a maximum value of $F_x = f_x \cdot Q_0$
on each wheel, where f_x is the frictional coefficient
35   between wheel and rail, obtainable in the longitudinal
direction, and Q_0 is the vertical load on each wheel.

As an example may be mentioned that, on the leading wheel
set, the steering forces are directed forwards on the outer-
curve wheels and directed backwards on the inner-curve
wheels. The couple of forces thus arising on this wheel set

5   gives a torque $M = F_x \cdot B = f_x \cdot Q_0 \cdot B$, where B is the
lateral distance between the contact points of the wheels
with the respective rail.

The requirement for self-steering in a given curve radius R

10   is that the counteracting torque in the horizontal plane
from the attachment between the car body and the bogie, at
the angle of rotation $v = A/R$ occurring, is not greater than
the possible steering torque $M = f_x \cdot Q_0 \cdot B$.

15   If, for example, $f_x = 0.25$

                             $Q_0 = 60$ kN

                             $B = 1.5$ m

     then $M = 22.5$ kN,

20

which value the moment of force at the attachment at the
angle $v = A/R$ must not exceed in order to obtain self-
steering. With, for example, $A = 5$ m and $R_{min} = 200$ m, the
angle v becomes $v = 2.5$ mrad.

25

The rigidity to rotary motions in the horizontal plane for a
bogie according to the invention is shown in Figure 4b,
where the rigidity (defined as the quotient between torque
and angle of rotation) at the flexible attachment between

30   the car body and the bogie may be obtained from the curve
which, according to the figure, indicates the torque M_f in
the horizontal plane as a function of the angle of rotation
v_{bogie} in the horizontal plane between the bogie and the car
body. If the rigidity to small angles of rotation is high

35   (alt. A), the rigidity to large angles (> 5 mrad) may need
to be made lower (alt. B), so that the yaw resistance (the
torque against yawing) does not risk becoming higher than
the torque from the steering forces on the wheels (at nor-

mally occurring curves and normal friction between wheels and rails). The breakpoint for the curve according to alternative B may then be located at an angle of rotation which amounts to, for example, 1 - 5 mrad.

CLAIMS

1. A single-axle self-steering bogie intended for a track-
bound vehicle comprising a car body (4) and at least one

5   load-carrying bogie, attached by means of a flexible attach-
ment (6) to the car body, with a wheel set (8) and wherein
each wheel (8a, 8b) in the wheel set is rigidly connected to
a wheel axle (14), which is attached rigidly or by means of
a primary spring (10) to a bogie frame (2), wherein the

10   bogie frame, in its turn, is rotatably arranged around a
vertical axis and is joined to the car body (4) of the
vehicle via at least one toggle link (16) extending in the
longitudinal direction of the vehicle and preventing the
bogie from tilting in the vertical longitudinal plane of the

15   vehicle, **characterized** in that the bogie is self-steering
in that the treads (18) of the wheels (8a, 8b) exhibit such
a great effective conicity that the steering forces which
are thus generated in the bogie when running through a
normal track curve (20) are at least as great as the forces

20   generated by the yaw resistance from the resilient attach-
ment (6) of the bogie to the car body (4), and thus align
the bogie radially in relation to the track in the track
curve.

25   2. A bogie according to claim 1, **characterized** in that
preferably two toggle links (16) which are articulately
connected at the connection to the car body (4) and to the
bogie frame (2), respectively, are arranged in parallel one
above the other in the same vertical plane.

30

3. A bogie according to claim 1 or 2, **characterized** in
that the bogie is provided with damping means (22) with a
speed-dependent characteristic which results in a damping of
the rotary motions of the bogie frame (2) in the horizontal

35   plane.

4. A bogie according to claim 3, **characterized** in that the
damping means (22) consist of dampers which are attached

horizontally between the outer sides of the bogie frame (2)
and the car body (4).

5. A bogie according to claim 3 or 4, **characterized** in
that the damping means (22) have a speed-dependent
characteristic which results in a higher damping of those
rotary motions in the horizontal plane of the bogie frame
(2) which have a low amplitude and a frequency greater than
about 2 Hz than for large but low-frequency rotary motions.

6. A bogie according to any of claims 3-5, **characterized**
in that the dampers (22) are of hydraulic type or consist of
friction-type dampers.

7. A bogie according to any of claims 1-6, **characterized**
in that the bogie exhibits a flexible attachment (6) to the
car body (4) which gives the bogie a rigidity at least in
relation to small bogie movements in the horizontal plane.

8. A bogie according to claim 7, **characterized** in that the
flexible attachment (6) consists of a spring arrangement.

9. A bogie according to claim 7, **characterized** in that the
flexible attachment (6) comprises at least one pair, at each
outer side of the bogie, preferably in the longitudinal
direction of the vehicle, of spring means attached between
the outer sides of the bogie and the car body, said spring
means jointly providing a rigidity in the direction of
rotation which is greater for small angles of rotation (< 5
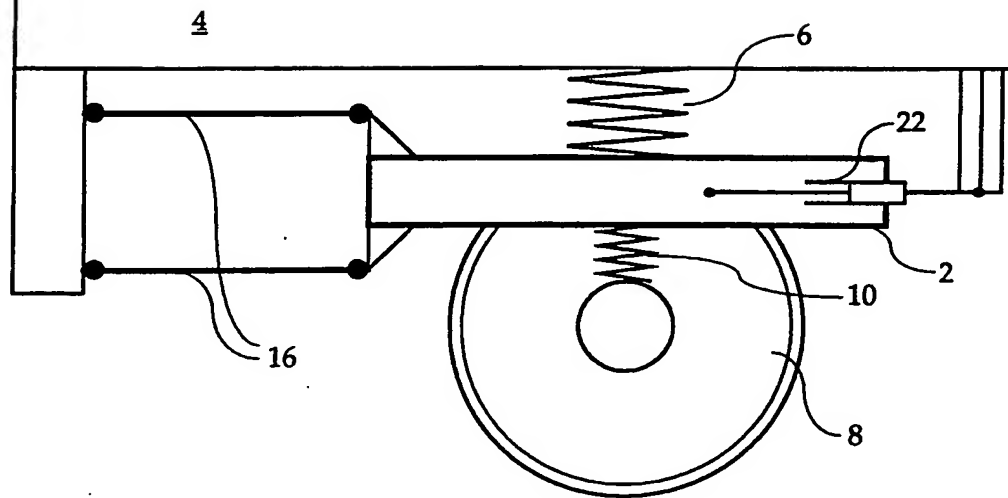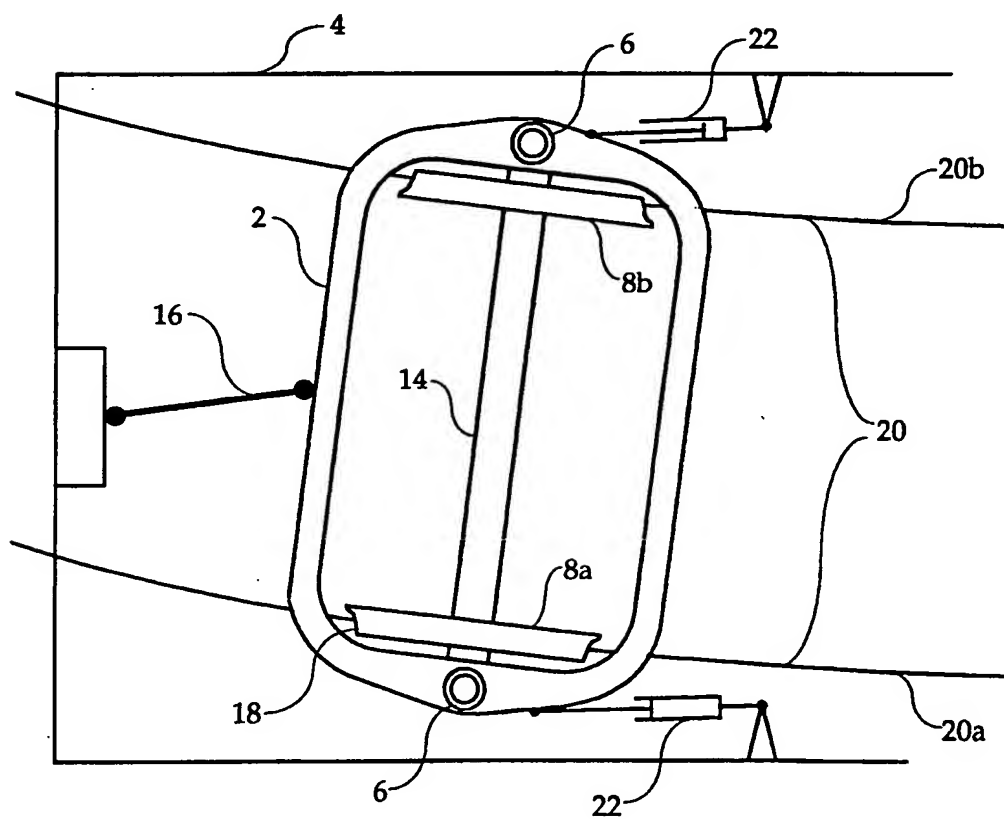mrad) than for large angles.
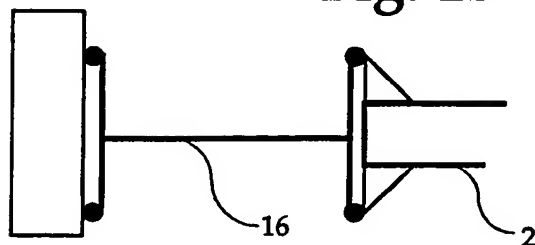
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Fig . 1
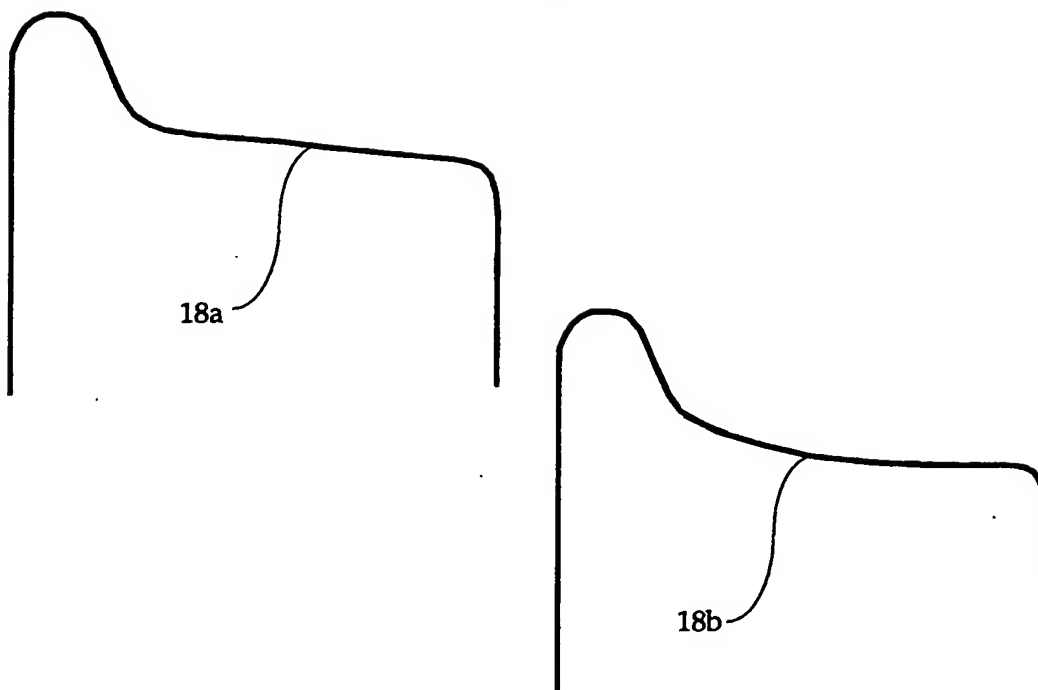

Fig . 2

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Fig. 1b

Fig. 3
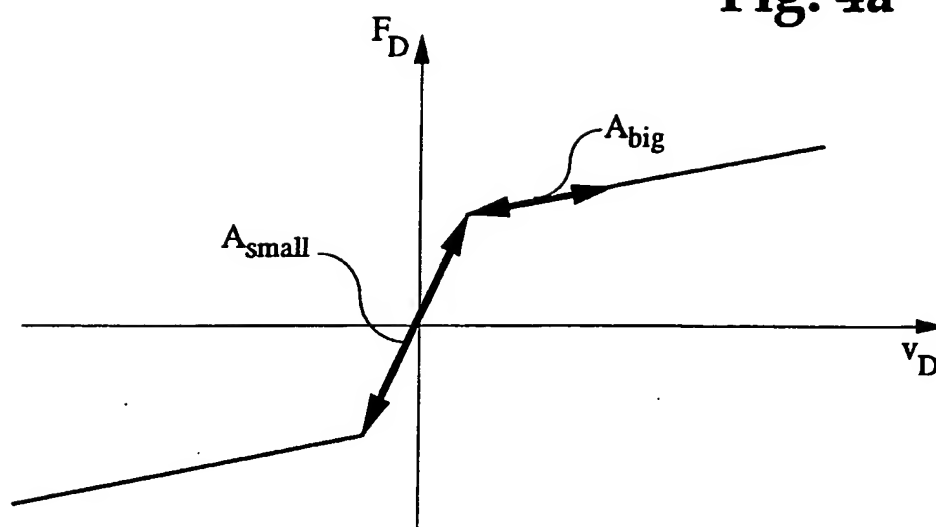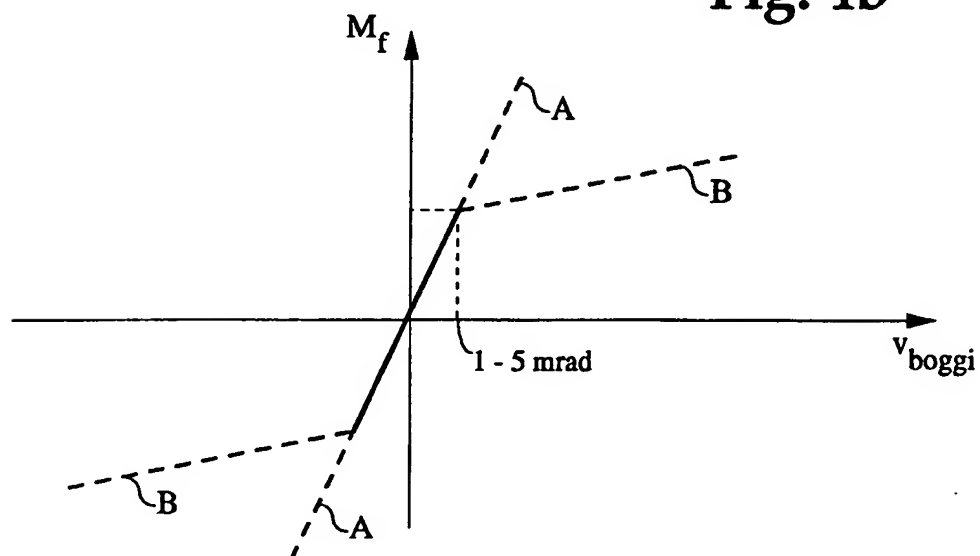
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Fig. 4a

Fig. 4b

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 93/00766

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: B61F 5/38

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: B61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	DE, A1, 3718254 (FREDERICH, FRITZ), 15 December 1988 (15.12.88)	1-9
A	US, A, 4067261 (SCHEFFEL), 10 January 1978 (10.01.78)	1-9
A	EP, A1, 0507146 (DUEWAG AKTIENGESELLSCHAFT), 7 October 1992 (07.10.92)	1-9

| [X] | Further documents are listed in the continuation of Box C. | [X] | See patent family annex. |

* Special categories of cited documents:

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"P" document published prior to the international filing date but later than the priority date claimed

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Date of the actual completion of the international search	Date of mailing of the international search report
29 December 1993	0 4 -01- 1994

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

	International application No.
	PCT/SE 93/00766

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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			JP-C-	1218029	17/07/84
			JP-A-	50143212	18/11/75
			JP-B-	58048383	28/10/83
			SE-B,C-	393071	02/05/77
			SE-A-	7503744	06/10/75
			US-A-	4067262	10/01/78
EP-A1-	0507146	07/10/92	DE-A-	4110492	01/10/92
SE-B-	381848	22/12/75	DE-A-	2315427	10/10/74
DE-A1-	3942235	04/07/91	NONE		
DE-A-	1605114	23/07/70	CH-A-	471698	30/04/69
			GB-A-	1157798	09/07/69
			NL-A-	6614591	19/04/67
US-A-	1423895	25/07/22	NONE		